

A Redescription of *Cylicocyclus radiatus* (Nematoda: Cyathostominae), A Parasite of the Ass, *Equus asinus*, and Horse, *Equus caballus*

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ABSTRACT: *Cylicocyclus radiatus*, the type species of the genus, a rare, but cosmopolitan species of small strongyle from horses, is redescribed to provide the information required for its identification and differentiation from other species of the genus. Type specimens discovered in the British Museum of Natural History were included among the specimens from *Equus asinus* from Egypt and *Equus caballus* from Kazakhstan, Ukraine, Panama, Canada, and the United States of America that formed the basis for this redescription. *Cylicocyclus radiatus* is distinguished by its large buccal capsule with relatively thin, straight walls; the absence of a dorsal gutter; inconspicuous leaf crowns; and a small indistinct esophageal funnel. The most similar species is *C. triramosus* of zebras, which can be distinguished by the presence of a dorsal gutter and distinct dorsal and ventral notches in the mouth collar.

KEY WORDS: Nematode systematics, Cyathostominae, Strongylidae, horse, *Cylicocyclus*, *Equus caballus*.

The small strongyles (Subfamily Cyathostominae) can cause considerable morbidity and mortality in horses (Herd, 1990). Currently, research interest is high because of the recognition of a new disease syndrome caused by larval stages in the wall of the large intestine and caecum (Mair, 1994), the development of widespread drug resistance (Coles, 1994), efforts to develop alternative control methods (Bird and Herd, 1995), and research on alternative identification methods for larval stages. Progress in all areas of this research requires accurate species identification of adult stages of the nematodes.

Nematodes of the genus *Cylicocyclus* are among the most numerous among the Cyathostominae parasitic in horses, and the genus includes at least 12 species. Until recently, several species of this genus were among the most difficult to identify because of inaccurate or confusing descriptions in the literature. Recently, redescriptions (Kharchenko et al., 1997; Lichtenfels et al., 1997) of several species of *Cylicocyclus* have provided the information needed to identify some of the problem species including

C. ashworthi (Le Roux, 1924), *C. nassatus* (Looss, 1900), and *C. triramosus* (Yorke and Macfie, 1918). The objective of the present study is to provide an improved description of *C. radiatus* (Looss, 1900), the type species of the genus.

Although *C. radiatus* is not often present in large numbers in horses (Foster, 1936; Torbert et al. 1986), it is cosmopolitan in distribution and the species can be difficult to separate from the similar, more numerous species *C. ashworthi*, *C. nassatus*, and *C. leptostomus* (Kotlan, 1920).

Materials and Methods

The discovery by Eileen Harris of type specimens of *C. radiatus* in the British Museum made this redescription possible. Other specimens studied are listed in Table 1. Many of the available specimens were in poor condition. Workers collecting this species in the future are encouraged to deposit specimens in museum collections to provide good specimens for future studies.

Nematodes were cleared for study in temporary wet mounts in phenol-alcohol (80 parts melted phenol crystals and 20 parts absolute ethanol) and studied with the aid of interference contrast light microscopy. Measurements are in micrometers unless indicated otherwise (Table 2). Papillae of the genital cone are num-

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Table 1. Geographic locality, host, number and sex of type, and voucher specimens of *Cylicocycl*us *radiatus* studied.

Geographic locality	Host	Collection no.*	Number studied			Collector
			Males	Females		
Lethbridge, Alberta, Canada	<i>Equus caballus</i>	18804*	5	4	Voucher	Hadwen, S.
Lethbridge, Alberta, Canada	<i>Equus caballus</i>	18934*	5	5	Voucher	Hadwen, S.
Panama	<i>Equus caballus</i>	58487*	0	3	Voucher	Foster, A. O.
Lexington, Kentucky	<i>Equus caballus</i>	78701*	2	2	Voucher	Lyons, E. T.
Kazakhstan, Ural Region	<i>Equus caballus</i>	86813*	3	3	Voucher	Kharchenko, V. A.
Ukraine	<i>Equus caballus</i>	86814*	1	0	Voucher	Kharchenko, V. A.
Egypt	<i>Equus asinus</i>	1931:261–262†	1	1	Types	Looss, A.
Egypt	<i>Equus asinus</i>	1968:249†	1	1	Voucher	Looss, A.

* U.S. National Parasite Collection Number, Beltsville, Maryland 20705.

† British Museum of Natural History, London.

bered following the system of Chabaud et al. (1970), in which the single ventral papilla is numbered “0” and the paired dorsal papillae are numbered “7’s.”

Photomicrographs were obtained with a 35-mm camera mounted on an Olympus Vanox research microscope, usually at a magnification of $\times 100$ –400 using Kodak Tmax 100 black and white negative film.

Drawings were prepared with the aid of a camera lucida.

Redescription

*Cylicocycl*us *radiatus* (Looss, 1900)

Chaves, 1930

(Figs. 1–18)

= *Cyathostomum radiatum* Looss, 1900

= *Cylichnostomum radiatum* (Looss, 1900)
Looss, 1902

= *Cylicostomum radiatum* (Looss, 1900)
Gedoelst, 1903

= *Cylicostomum* (*Cylicocycl*us) *radiatus*
(Looss, 1900) Ihle, 1922

= *Trichonema radiatum* (Looss, 1900)
Le Roux, 1924

= *Cylicostomum prionodes* Kotlan, 1921;
Skrjabin and Ershov, 1933

GENERAL: With characteristics of genus *Cylicocycl*us Ihle, 1922: mouth collar high with broad lateral papillae that extend through collar (Figs. 1–3, 11–13). Submedian papillae, with spindle-shaped tips, extend beyond lateral papillae (Figs. 2, 3, 14). External leaf crown (ELC) with about 26 long, narrow, inconspicuous elements that bend in the middle toward the mouth and do not extend beyond the mouth collar (Figs. 2, 3, 12). Internal leaf crown (ILC) with

about 50 small, thin rectangular plates (Figs. 2, 3, 11, 12). Buccal capsule slightly ellipsoidal, wider laterally (Figs. 2, 12) than dorsoventrally (Figs. 3, 11); walls thin anteriorly, thicken only slightly anterior to relatively large hooplike ring at base (Figs. 2, 3, 11, 12). Buccal cavity relatively large, twice as wide as deep in freshly mounted specimens (Figs. 2, 3, 11, 12) and 3 times as wide as deep in specimens partially flattened under the weight of a cover glass (Table 2). Duct of dorsal esophageal gland empties at base of buccal cavity (Fig. 15); dorsal gutter absent. Excretory pore (Fig. 1) and cervical papillae (Figs. 1, 10) at same level posterior to nerve ring at point where esophagus widens posteriorly.

MALES: ($N = 18$) (measurements in Table 2) Copulatory bursa of average size, but dorsal lobe slightly elongate and distinctly set off from lateral lobes (Figs. 5, 17). Distal branches of dorsal ray with accessory branches (Fig. 17). Ventral projection of genital cone surrounded by well-developed dermal collar (Figs. 7, 9, 18). Dorsal to vent genital cone bears paired, bilobed, bubblelike opaque genital appendages through each of which passes a single No. 7 papilla (Figs. 9, 18). The genital appendages also bear tiny nipplelike points (Fig. 18).

FEMALES: ($N = 19$) (measurements in Table 2) Posterior end of female relatively straight, but small lateral prominences present anterior to anus; tail tapers sharply to a thin cone for most of its length. Tail slightly shorter than vulva to anus distance (Figs. 6, 16). Vagina long, vestibule short, paired sphincters and infundibula elongate (Fig. 6), the latter slightly longer than the former (Table 2).

Table 2. Morphometrics (in micrometers); range with mean in parentheses of males and females of *Cylicocyclus radiatus*.

Character	Males	Females
Number of specimens	18	19
Body length (mm)	7.34–12.4 (9.39)	8.53–12.6 (10.6)
Diameter at E-I	300–465 (332)	281–401 (366)
Buccal capsule width	112–191 (149)	120–191 (151)
Buccal capsule depth	45–60 (56)	48–60 (56)
Nerve ring*	401–506 (451)	398–544 (470)
Cervical papillae*	454–675 (531)†	438–686 (552)‡
Excretory pore*	431–675 (518)	412–690 (558)§
Esophagus length*	806–1,050 (890)	907–1,068 (990)
Esophagus width at bulb	150–356 (218)	157–281 (222)
Egg (length × width)	—	80–100 (91) × 45–56 (51)
Vulva to anus distance	—	178–281 (220)
Vagina length	—	375–1,005 (701)
Vestibula length	—	75–135 (89)
Sphincter length	—	210–345 (288)
Infundibulum length	—	258–420 (298)
Spicule length (mm)	1.58–1.84 (1.69)	—
Gubernaculum length	206–300 (260)	—
Dorsal ray length	536–750 (650)	—
Tail length	—	131–210 (178)§

* Measured from anterior end.

† *N* = 16.‡ *N* = 17.§ *N* = 18.|| *N* = 15.**Taxonomic summary**

TYPE HOST: *Equus* (Looss found it in both horse and ass; available types are from the latter).

LOCATION IN HOST: Colon and caecum.

TYPE LOCALITY: Egypt.

DISTRIBUTION: Cosmopolitan.

TYPE SPECIMENS: One male and 1 female in British Museum of Natural History, London.

COLLECTION NUMBER: 1931:261–262.

OTHER SPECIMENS: Table 1.

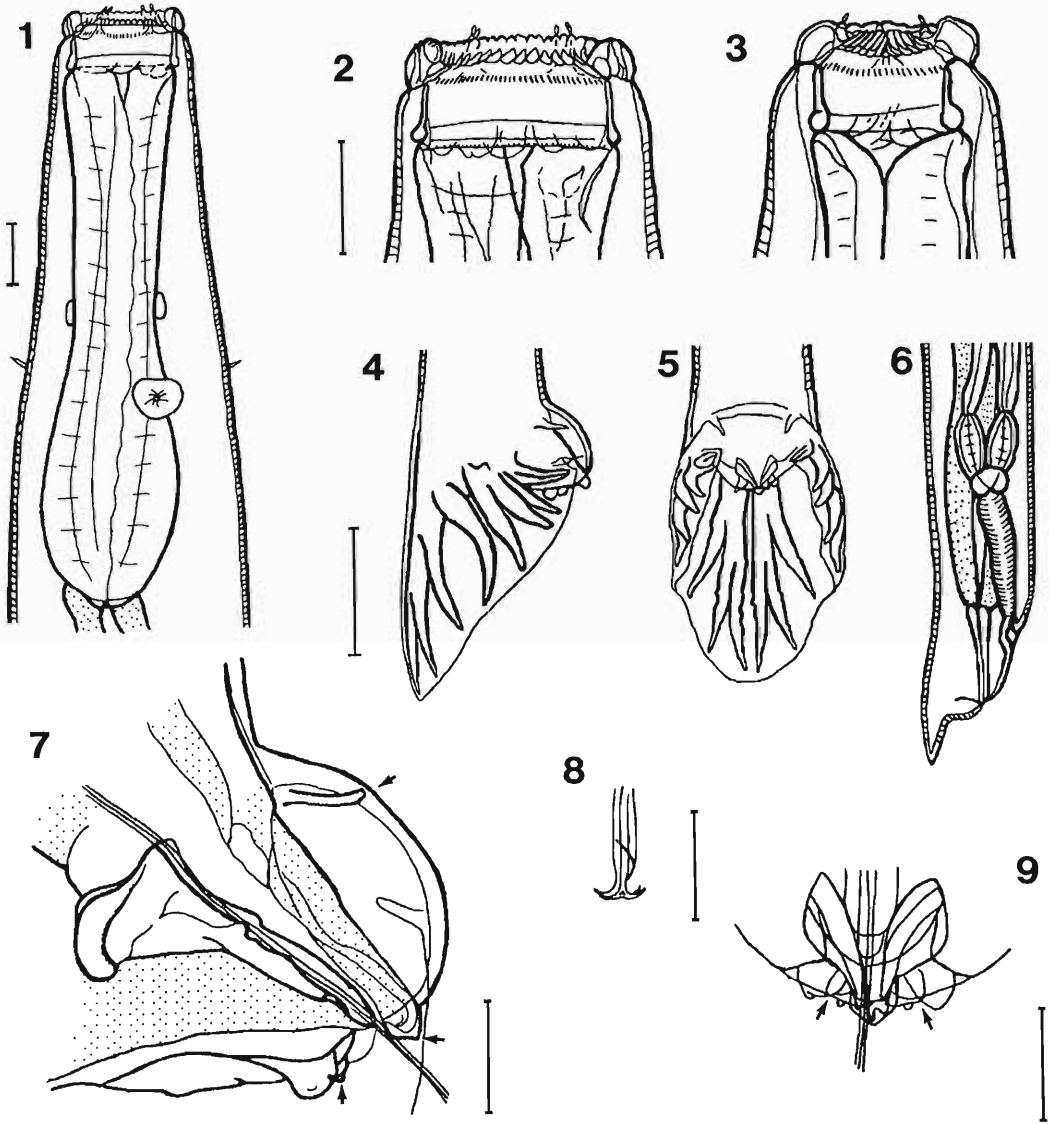
Remarks

Like all species of the Cyathostominae, *Cylicocyclus radiatus* can be distinguished in cleared whole specimens by characteristics of the buccal capsule and associated structures of the anterior end (Looss, 1900, 1902; Lichtenfels, 1975; Hartwich, 1986; Dvojnos and Kharchenko, 1994). The thin, relatively straight-walled, large buccal capsule and small esophageal funnel are sufficient to distinguish this species from its congeners (Lichtenfels, 1975). The smaller buccal capsule species of *Cylicocyclus* parasitic in *Equus caballus* or *Equus asinus* all have dorsal gutters, which *C. radiatus* lacks. Included in the

small buccal capsule group are *C. nassatus*, *C. ashworthi*, and *C. leptostomus*, all of which have dorsal gutters in addition to smaller buccal capsules. Two of these, *C. nassatus* and *C. ashworthi*, have been redescribed recently (Lichtenfels et al., 1997).

Two species of *Cylicocyclus* have been described with extremely shallow buccal capsules: *C. brevicapsulatus* (Ihle, 1920), which has a distinctive short, thin buccal capsule wall, and *C. prionodes* Kotlan, 1921, which has been synonymized with *C. radiatus* by Skrjabin and Ershov, 1933, who found this species to be composed of distorted specimens of *C. radiatus* in which the esophagus is pushed forward displacing the buccal capsule, flaring and spreading the elements of the leaf crowns. Lichtenfels (1975) confirmed this synonymy and illustrated such distorted specimens.

The larger buccal capsule species of *Cylicocyclus* include *C. auriculatus* (Looss, 1900), *C. ultrajectinus* (Ihle, 1920), *C. insigne* (Boulenger, 1917), and *C. elongatus* (Looss, 1900); all, like *C. radiatus*, lack a dorsal gutter, and can be distinguished from *C. radiatus* by their concave curve in the wall of the buccal capsule and the

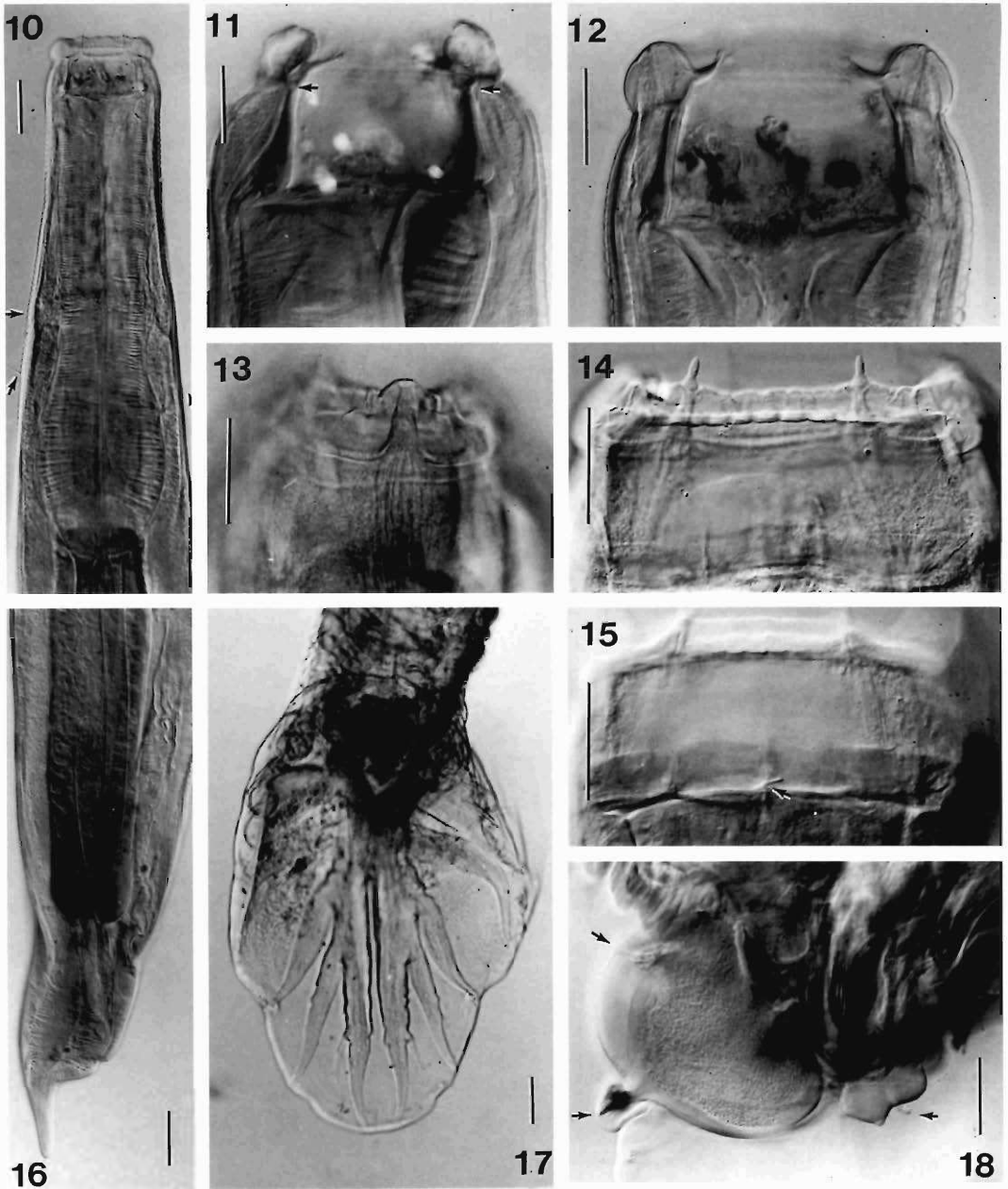


Figures 1–9. *Cylicocyclus radiatus*, drawings. Scale bars = 100 μ m (Figs. 1–3, 7, 9), 400 μ m (Figs. 4–6), and 50 μ m (Fig. 8). 1. Esophageal region, ventral view. 2. Buccal capsule, dorsoventral view. 3. Buccal capsule, lateral view. 4. Male tail, lateral view. 5. Male tail, ventral view. 6. Female tail, lateral view. 7. Genital cone of male, lateral view, showing positions of prebursal papillae (top arrow), papilla No. 0 (middle arrow), and papillae No. 7 (bottom arrow). 8. Fused spicule tips of male. 9. Appendages of genital cone, ventral view, showing paired dorsal papillae No. 7 (arrows).

distinctive natures of their prominent esophageal funnels (Lichtenfels, 1975). In addition, characteristics of lateral and submedian papillae and/or ELC and ILC (Lichtenfels, 1975) can be used to further differentiate these species from *C. radiatus*.

Two species of *Cylicocyclus* that occur only

in zebras, *C. triramosus* and an undescribed species of *Cylicocyclus*, are similar to *C. radiatus*. A recent redescription (Kharchenko et al., 1997) of *C. triramosus* clearly differentiated it from *C. radiatus*. Among all species of the genus, *C. triramosus* is most similar to *C. radiatus*, but differs in having a small dorsal gutter, distinctive



Figures 10–18. *Cylicocyclus radiatus*, photomicrographs. Scale bars = 50 μ m (Figs. 11–15, 18) and 100 μ m (Figs. 10, 16, 17). 10. Anterior end, dorsal view, showing shape of esophagus, position of nerve ring (anterior arrow), and cervical papillae (posterior arrows). 11. Buccal capsule, lateral view, showing inflated mouth collar, elements of ELC and ILC and extrachitinous supports (arrows). 12. Buccal capsule, dorsoventral view, showing lateral papillae extending through inflated mouth collar, and elements of ELC and ILC. 13. Mouth collar, lateral view, showing lateral papilla projecting through slightly collapsed collar. 14. Submedian papillae, dorsal view, showing spindle shape of papillae tips. 15. Anterior extremity of duct of dorsal esophageal gland (arrow) showing lack of dorsal gutter. 16. Female tail, lateral view, showing vulva and anus. 17. Male tail, ventral view, showing left externodorsal ray and 6 branches of dorsal ray. Small accessory branches are present on the distal or main branches of the dorsal ray. 18. Genital cone of male, lateral view, showing prominent ventral dermal collar with prebursal papillae (top left arrow),

dorsal and ventral notches in the mouth collar, and distinctive appendages of the genital cone. *Cylicocycclus gyalcephaloides* lacks a dorsal gutter and has a buccal capsule of similar shape to that of *C. radiatus*, but with thicker and slightly concave walls, a much larger and more prominent ILC, a prominent ELC that extends beyond the mouth collar, and a shorter, broader dorsal bursal ray.

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cuticular projection (lower left arrow), and one of paired bilobed genital appendages at dorsal edge of vent. The bilobed genital appendage bears tiny nipplelike points and surrounds one of a pair of dorsal papillae (No. 7's) (right arrow).